# RESEEDING SOUTHWESTERN RANGE LANDS WITH CRESTED WHEATGRASS



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# CONTENTS



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# RESEEDING SOUTHWESTERN RANGE LANDS WITH CRESTED WHEATGRASS

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## INTRODUCTION

Crested wheatgrass is being used successfully to improve the forage production of many deteriorated range lands in the cooler and moister parts of the Southwest. This species gives high forage yields, supplies green forage in both spring and fall; plants withstand grazing well; and the weight gains of animals grazed on it are good.

Since many native grasses of the Southwest are summer growers, the spring-fall growth of crested wheatgrass furnishes valuable complementary forage. At lambing and calving time, the green forage is especially valuable because it supplies a high level of nutrition. Moreover, grass-fat animals are desirable for fall shipment to feeding and slaughtering areas. Crested wheatgrass, therefore, may serve a special need in many range-improvement programs.

Crested wheatgrass is adapted to moderately moist sites within big sagebrush and pinyon-juniper vegetational types, and throughout ponderosa pine range lands of Arizona and New Mexico. Production of forage has been greatly reduced in parts of many such ranges because they have been abandoned after unprofitable farming operations, have been unwisely grazed, or have been invaded by undesirable shrubs. On these deteriorated sites, reseeding with crested wheatgrass pays dividends.

This bulletin presents what has been learned thus far by the Southwestern Forest and Range Experiment Station about the possibility and practicability of planting and grazing crested wheatgrass in Arizona and New Mexico. Interested individuals can apply this experience to their own lands, benefit economically thereby, and, by more experience, further the knowledge now available on ways in which crested wheatgrass can be employed in land restoration and improvement.

## EARLY TRIALS

Crested wheatgrass is not new as a reseeding species. It was introduced into the United States from Russia in 1898. Trial plantings were made during the following 35 years by the Bureau of Plant Industry, Soils, and Agricultural Engineering, U. S. Department of

[1] Maintained by the Forest Service, U. S. Department of Agriculture, for Arizona, New Mexico, and west Texas, with headquarters at Tucson, Ariz.

Agriculture, in the northern Great Plains region and by State workers in Washington, Oregon, Colorado, and Montana.

Interest in the new grass developed gradually throughout the West. Progress in the use of crested wheatgrass during the past 18 years has been more rapid. In 1939 the Bureau of Plant Industry, Soils, and Agricultural Engineering considered the major distribution to be restricted to Washington, Idaho, Montana, Wyoming, the Dakotas, and small parts of Oregon and Nebraska. Minor distribution extended into Utah, Nevada, Colorado, northern New Mexico and Arizona, and northwestern Kansas. By 1952 the distribution included more of Utah, Nevada, Arizona, and New Mexico; and extended into Oklahoma, Texas, and California.

Crested wheatgrass is considered by the Soil Conservation Service [2] to be adapted for planting submarginal farm lands and deteriorated ranges in western and northeastern New Mexico except those in the Rio Grande Valley and the southern third of the State; and in Arizona north of the Colorado River and along the Mogollon Plateau. Continued observation of plantings on which this recommendation was based has shown that site selection is important in these areas if crested wheatgrass plantings are to be long-lived.

Range reseeding experiments conducted by the U. S. Forest Service in Arizona and New Mexico date back to 1907. Crested wheatgrass was included in experimental trials when a seed source became available in the early twenties. It also was used in limited reseeding work under the Civilian Conservation Corps program from 1933 to 1942. Under a special congressional appropriation made in 1945 for research on the reseeding of range lands, crested wheatgrass, among other species, has been rigorously tested to obtain information on its adaptability, methods of establishing it economically, and grazing returns to be expected from it. These tests were made by the Southwestern Forest and Range Experiment Station in cooperation with the National Forest Administration, Soil Conservation Service, Bureau of Plant Industry, Soils, and Agricultural Engineering, Bureau of Land Management, State universities, and private landowners. Large-scale plantings on Federal and private lands have also yielded much practical information on use of this grass on range lands.

## SPECIES CHARACTERISTICS

Crested wheatgrass is a hardy perennial bunchgrass producing an abundance of basal and stem leaves. Its root system is wide spreading and deep penetrating. It has a high resistance to cold, drought, and grazing and it produces a large volume of palatable, good-quality forage.

Seed of crested wheatgrass is comparatively large—about 175,000 seeds per pound—is easily handled, and if kept cool and dry, stores well for at least 3 to 5 years. Seeds planted to a depth of not more than ¾ inch will emerge as seedlings in about 10 days, provided soil moisture and temperatures are favorable. At that time the primary root will have penetrated approximately 1 inch. In 1 month roots reach to a depth of 6 inches. Roots of mature plants may reach a

[2] Regrassing for soil protection in the Southwest. U. S. Dept. Agr. Farmers' Bul. 1913, 60 pp., illus. 1942.

depth of 8 feet and have a lateral spread of 2 feet. The majority of the roots are concentrated in the first 3 feet of soil.

Seed of crested wheatgrass is sold on the commercial market under the names of Standard and Fairway. Recently some authorities have designated these so-called "strains" as different species, classifying Standard as *Agropyron desertorum*, and Fairway as *A. cristatum*. In the field, Fairway crested wheatgrass can be distinguished from Standard by its more numerous and finer stems, its hairy leaves, and its more uniform height growth.

Standard crested wheatgrass appears to be slightly better adapted than Fairway in Arizona and New Mexico. Improved selections of both species are now being planted experimentally, but testing has not proceeded far enough to justify the development of a commercial seed supply of the superior selections.

## RANGE OF ADAPTABILITY

Numerous experimental plantings of crested wheatgrass have been made throughout Arizona and New Mexico since 1945. These have progressed from small 12-foot row plantings where the adaptability of the species was tested to ¼- to 1-acre plots for herbage yield tests, pilot plots of 1- to 100-acres, and single range-improvement plantings covering up to 5,000 acres. Detailed and repeated measurements and observations on these and other plantings have yielded much information on the localities in which crested wheatgrass can be planted successfully in Arizona and New Mexico.

### Climatic Limitations

The most serious limitation on the growing of crested wheatgrass in the Southwest is rainfall deficiency. It is possible, in a general way, to determine whether crested wheatgrass will grow in a specific locality by the vegetation found there. For example, such vegetation as spruce-fir and ponderosa pine, big sagebrush, and pinyon-juniper reflect the amount of precipitation received by areas in which they are found. Crested wheatgrass does especially well throughout the ponderosa pine range type. It does slightly less well in the spruce-fir range type. Species other than crested wheatgrass, that make better use of the higher rainfall, are available for planting range land in the spruce-fir type.

Crested wheatgrass may be planted to a limited degree in both the pinyon-juniper and big sagebrush range types, depending upon the average annual precipitation. In the pinyon-juniper type, plantings have not survived well on sites with less than 15 inches annual precipitation. Most plantings made in big sagebrush type areas of the Southwest with less than 12 inches of annual precipitation have been failures.

Crested wheatgrass may be planted in Arizona and New Mexico with little regard for temperature alone. Nowhere have plants winterkilled. On the lower, hotter areas, drought killing masks any losses which might be attributed to heat itself. Furthermore, crested wheatgrass is protected against injury from drought, once it is established, by its habit of becoming dormant during hot, dry periods.

## Soil Requirements

Crested wheatgrass grows best on soils ranging from light sandy loams to medium clays. Herbage production is below average on very sandy soils and on heavy clay soils. Best growth is made on soils that allow rainfall to penetrate, and that have good water-holding capacity, such as those having a heavy-loam texture and good drainage. Soils that tend to "seal off" on the surface and thus prevent good rainfall penetration are difficult to reseed and produce only a poor growth of crested wheatgrass. Sandy or loamy surface soils are best because they permit good rainfall absorption, an important factor in bringing about successful reseeding under the climate of Arizona and New Mexico. An ideal soil for maximum herbage production is one at least 2 feet deep having a well-developed profile of sandy-loam surface 2 to 6 inches deep, underlain by a clay of blocky structure.

## Herbage Production

It is extremely important that plants to be used for grazing produce a large volume and a good quality of herbage.

*Site differences.*—The potential production of herbage by crested wheatgrass varies widely with growing conditions, mainly with differences in precipitation. This is shown by herbage production samples taken in 1949 on 11 representative sites within the ponderosa pine, pinyon-juniper, and big sagebrush range types (table 1). All plantings had gone through three or more growing seasons. They were well established, had been protected from grazing, and were considered to be fully occupying the sites.

A satisfactory stand of crested wheatgrass will probably average about one-half ton of air-dry herbage per acre in ponderosa pine and

TABLE 1.—*Herbage production of crested wheatgrass at several locations in 1949, a favorable year, as related to elevation and precipitation*

| Dominant woody vegetation | Plot location | Elevation | Average annual precipitation | Herbage production (air-dry) |
|---|---|---|---|---|
| | | *Feet* | *Inches* | *Pounds per acre* |
| Ponderosa pine | Jarita Mesa, N. Mex. | 8, 300 | 24 | 1, 140 |
| | Fort Valley, Ariz. | 7, 400 | 23 | 1, 180 |
| | McGaffey, N. Mex. | 8, 000 | 18 | 1, 060 |
| | Entranas Canon, N. Mex. | 7, 930 | 17 | 1, 140 |
| Big sagebrush | Costilla, N. Mex. | 7, 450 | 17 | 1, 200 |
| | Tres Piedras, N. Mex. | 8, 080 | 16 | 1, 380 |
| | Cebolla Mesa, N. Mex. | 7, 670 | 14 | 1, 020 |
| | Taos, N. Mex. | 6, 980 | 13 | 880 |
| Pinyon-juniper | Glorieta Mesa, N. Mex. | 7, 380 | 16 | 800 |
| | Dog Knobs, Ariz. | 6, 400 | 15 | 640 |
| | Corona, N. Mex. | 6, 670 | 15 | 520 |

favorable big sagebrush sites. Yields of a ton or more have been obtained in some years on better sites. In the pinyon-juniper sites herbage production usually averages somewhat less than one-half ton per acre. Big sagebrush sites were superior to pinyon-juniper sites of similar average rainfall because they were farther north and at higher elevations, with lower temperatures and slower rates of evaporation.

*Annual variations.*—Wide variations occur in the production of herbage by crested wheatgrass on any given site. For example, between 1947 and 1951, production of herbage on Glorieta Mesa in New Mexico varied from 200 pounds per acre in 1951 to 800 pounds per acre in 1949.

The amount of precipitation received by an area has considerable effect on the herbage production of crested wheatgrass. The degree of rainfall from November to June is of special importance (fig. 1) particularly on the hotter and drier sites at lower elevations where proportionately more summer moisture is lost to the atmosphere. On such sites crested wheatgrass undergoes longer periods of summer dormancy.

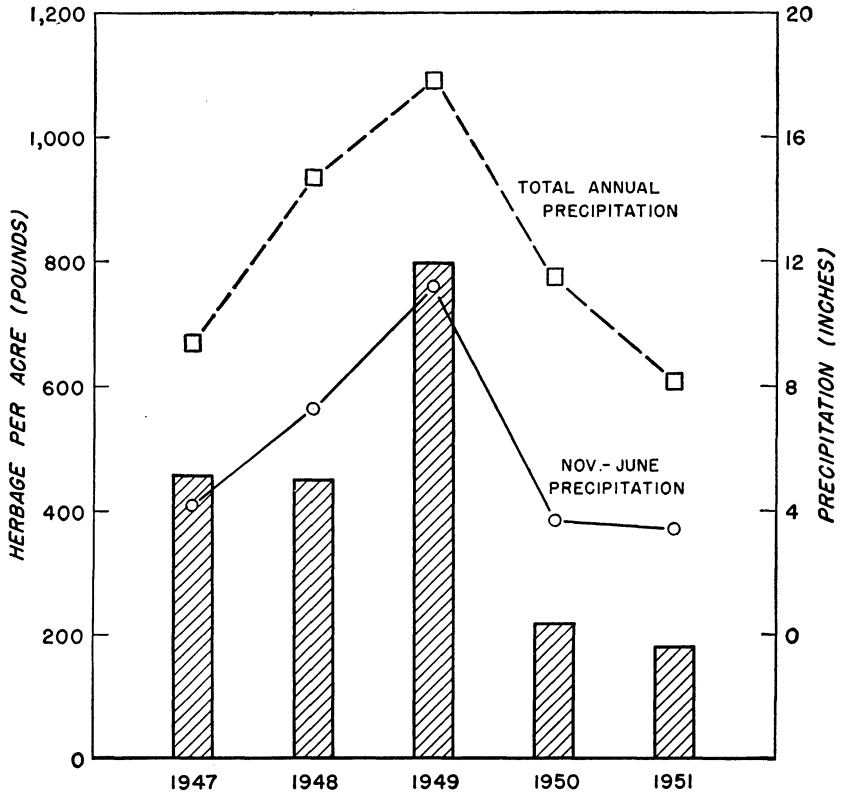


FIGURE 1.—Production of crested wheatgrass on Glorieta Mesa in New Mexico in relation to amount and distribution of precipitation.

## Planting Sites

The general areas in which crested wheatgrass is adapted for reseeding are mapped in figure 2. In these areas crested wheatgrass has been able to reproduce itself, and forage production has averaged more than 500 pounds an acre. The areas mapped necessarily include some local sites that are unproductive because of soil or other conditions.

Numerous natural openings occur in ponderosa pine forests along the Mogollon rim in Arizona; and in the Gila, Jemez, and Sangre de Cristo Mountains in New Mexico. Many of these openings have deteriorated to a weedy cover that has little forage value. Nevertheless, they have favorable soil and can be made highly productive by planting crested wheatgrass in them (fig. 3). Crested wheatgrass is also useful as a protective soil cover where the native vegetation of the forest has been destroyed by fire or log skidding and hauling. Depleted wet meadows should be restored by planting species better adapted than crested wheatgrass to such moist sites, such as smooth brome (*Bromus inermis*), big bluegrass (*Poa ampla*), and orchard grass (*Dactylis glomerata*).

In the pinyon-juniper woodlands many openings of 20 acres or larger, occupied only by stunted blue grama or half-shrubs such as snakeweed and pingue, can be seeded successfully (fig. 4, *A*). Scattered pine trees and remnant plants of bluestem wheatgrass indicate that there is probably enough moisture for crested wheatgrass. Where galleta (*Hilaria jamesi*) is the dominant remnant grass, or average annual rainfall is less than 15 inches, success with crested wheatgrass is doubtful.

Big sagebrush lands, which occur mainly in north central and northwestern New Mexico and north of the Colorado River in Arizona, and which are not valuable as winter browse ranges for livestock or big game, also offer some excellent opportunities for establishing crested wheatgrass (fig. 4, *B*). Vigorous individual shrubs of big sagebrush more than 3 feet tall, growing in stands so dense as to make walking difficult, indicate that the soil is favorable and the rainfall probably is adequate. The presence of remnant bluestem wheatgrass is further evidence of favorable growing conditions.

Many abandoned farms and depleted ranges in the short-grass plains of northeastern New Mexico can also be reseeded successfully with crested wheatgrass, provided the topsoil is not too depleted.

# ESTABLISHING A STAND

## Planning

Careful site selection, the use of proper equipment and seed, the control and distribution of livestock, and an analysis of possible costs and returns all contribute to success in a range reseeding venture. Range reseeding is rather costly in relation to the usual value of the land and only careful preliminary planning will insure satisfactory returns on the investment.

*Site selection.*—Reseeding to crested wheatgrass is seldom justified where range productivity can be restored within a reasonable period

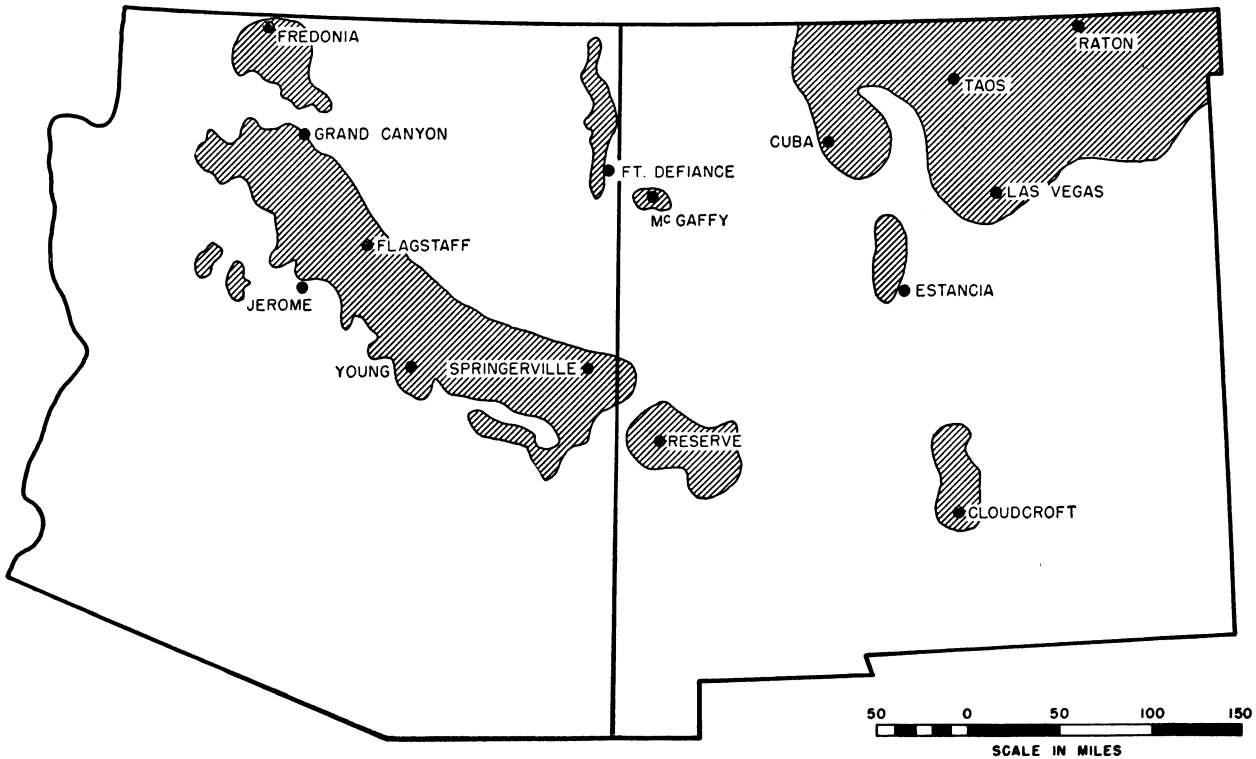


FIGURE 2.—General areas in Arizona and New Mexico in which crested wheatgrass can be used for range reseeding.

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FIGURE 3.—Deteriorated dry meadows within the pine forests of Arizona and New Mexico are excellent planting sites for crested wheatgrass. This park in northern New Mexico was producing only weeds, half-shrubs, and less than 80 pounds of perennial grass per acre. Two years after reseeding nearly *one-half ton* of crested wheatgrass was available for grazing.


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FIGURE 4.—*A*, Deteriorated pinyon-juniper woodland openings, where annual rainfall is in excess of 15 inches, will grow excellent stands of crested wheatgrass. *B*, Big sagebrush lands which produce little native forage, and on which annual rainfall exceeds 12 inches, can be converted successfully to crested wheatgrass. The best sites have deep soils, sagebrush more than 3 feet tall, and remnants of bluestem wheatgrass.

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by improved management practices such as moderate grazing, resting the range, or deferring grazing. Reseeding should be done first on ranges that have good growing conditions, but are supporting much less than their full forage capacity. The possible benefits of reseeding can sometimes be determined by comparing deteriorated ranges with properly managed or protected ranges under similar growing conditions. In general, if perennial grasses have been largely replaced by weeds, annuals, or half-shrubs or shrubs and there is little native seed source for desirable perennial grasses, reseeding is the best method of improving the range. Reseeding for range use is the only means of quickly restoring productivity on certain abandoned, cultivated areas where farm crops have proved unsuccessful.

The best available weather records should be consulted and the soil and native vegetation indicators carefully examined in deciding whether the site is within the range of adaptability described in this publication.

Excessively rocky soil and rough terrain should be avoided because they cause difficulty in using equipment. As a general practice, slopes in excess of 20 to 25 percent should not be seeded. If it is needed for watershed protection, seeding would be justified but might be costly. Even on more gentle slopes, equipment should be worked on the contour to reduce danger of erosion.

*Livestock control and management.*—In reseeded areas livestock must be controlled. A new stand of grass should not be grazed until plants develop strong root systems. With crested wheatgrass this requires two or more growing seasons. Provision must be made for proper livestock distribution within a reseeded unit. Improper distribution of livestock results in inefficient use of the grass and a loss of part of the investment. Fences and water developments should be planned in advance. Sheep can be herded for proper distribution, while cattle movements can best be controlled by cross fencing, water development, and carefully planned salting. Watering places should be no more than 1 mile apart so that livestock can take full advantage of the high grazing capacity of crested wheatgrass plantings. Cost of fencing and water development can be repaid many times by the more efficient use of forage obtained.

*Equipment and seed.*—It is very necessary to use sturdily constructed implements in good operating condition. Ordinary farm implements must be reinforced and must be carefully operated to reduce breakage, since range reseeding sites are generally more rocky and rough than cultivated lands.

The best seed available should be purchased well in advance of planting. Crested wheatgrass seed should test at least 85 percent for both purity and germination. If seed of lower quality must be used the amount planted per acre should be increased proportionately to insure good stands. Certified seed is recommended. A good practice is to purchase seed after crop harvest in the fall, and to store it in a cool, dry, rodent-proof place for use the following year.

## Site Preparation

Good site preparation is necessary for successful establishment of crested wheatgrass. Growing shrubs and weeds compete severely with

crested wheatgrass seedlings for available moisture. The more competing vegetation is removed, the more grass seedlings will be established. For example, at a big sagebrush site near Costilla, N. Mex., where 95 percent of the sagebrush was killed, perennial grass production at the end of the third growing season was almost twice that where only 34 percent of the sagebrush was destroyed, as shown in the following tabulation:

| Percent of big sagebrush killed: | *Perennial grass production (lb/acre, air-dry)* |
|---|---|
| 0 | 320 |
| 34 | 670 |
| 50 | 790 |
| 67 | 800 |
| 95 | 1,110 |

Of many implements tested in several vegetational types, disk-type plows and offset-disk harrows have proved most effective for destroying competing vegetation in this region.

The standard disk plow (fig. 5, *A*) will destroy more than 90 percent of such shrubs as rabbitbrush, sagebrush, and snakeweed. The principal drawback of this equipment is that it cuts a narrow swath and requires much power, hence is costly to operate.

The extra heavy duty (500 pounds or more per foot of cutting width) offset-disk harrow with scalloped disks (fig. 5, *B*) will eradicate almost all big sagebrush and nearly all half-shrubs on many range sites. This extra heavy duty implement has these disadvantages: It lacks depth control, its high power requirements give it a low operating efficiency, and it breaks easily on rocky sites. Its use should be confined to heavy, hard soils, free of large rocks. The heavy duty (250–500 pounds per foot of cutting width) offset-disk harrow effectively eradicates most types of brush if soils are not too rocky or hard.

The wheatland-type plow (fig. 6, *A*) is well adapted to site preparation where the soil is free of rocks, and competing vegetation is of the half-shrub type, such as pingue or snakeweed. Although it is slightly less effective than the standard disk plow under these conditions, the wheatland-type plow does a satisfactory job of soil preparation at considerably less cost.

The brushland plow recently developed by the Forest Service is rugged and versatile. For rough and rocky terrain, this plow gives the most efficient and economical site preparation of any equipment so far available (fig. 6, *B*). It operates like a disk plow. The disks are mounted in pairs of unequal size and are held in the ground by spring tension. The plow is so constructed that when it meets an obstruction, any pair of disks is free to rise while the remaining disks continue to cut. The "knee-action" feature permits use of the plow on rough and rocky sites which cannot be worked by other equipment. This plow removes big sagebrush and other competing vegetation efficiently, and leaves the soil in a friable condition for planting. It seldom breaks and in spite of its heavy construction requires comparatively little draft power. A D–7 tractor can easily pull two plows joined by a special hitch, and in this way the cost of site preparation is substantially reduced.

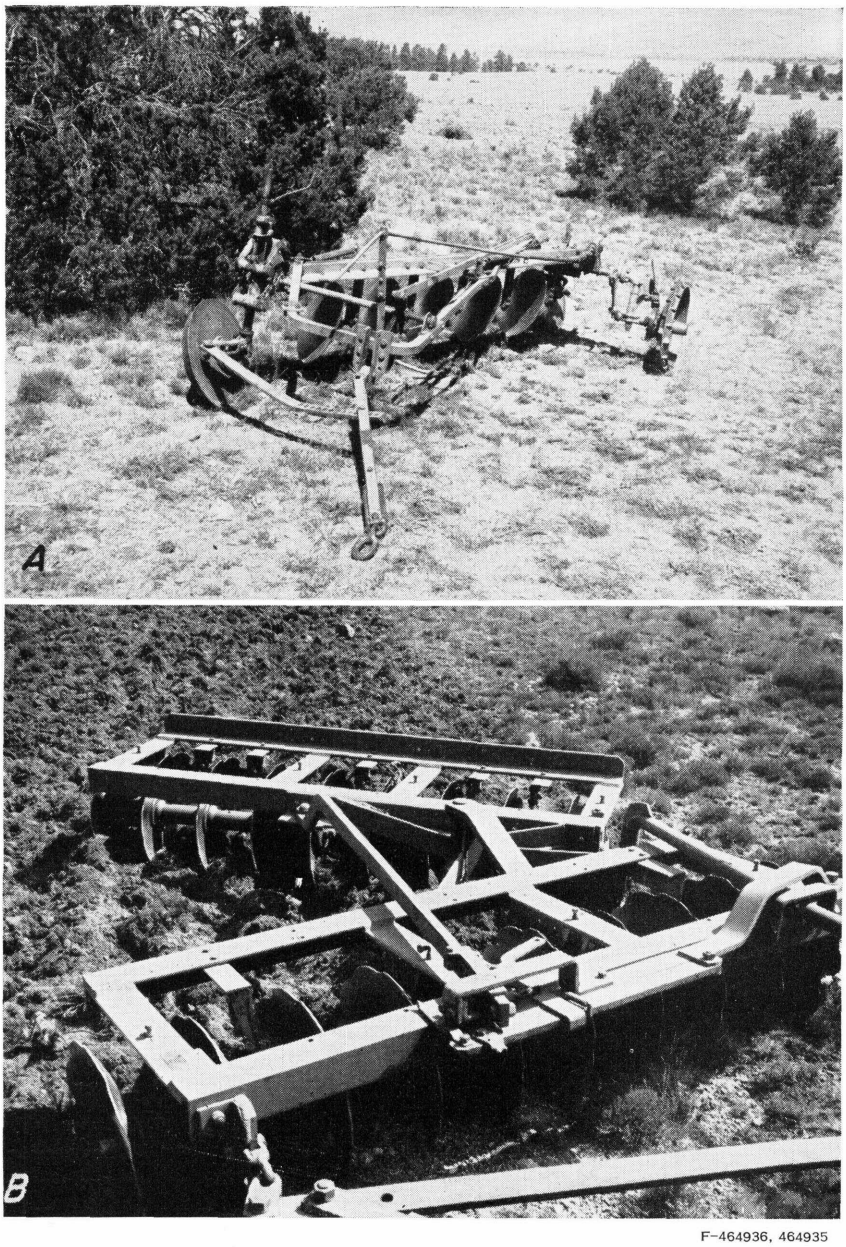


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FIGURE 5.—Two machines useful in reducing competing vegetation. *A*, The standard disk plow, although costly to operate, is very effective in killing heavy stands of brush. *B*, Extra heavy duty, offset-disk harrows are effective where the soil is heavy, compact, and dry.

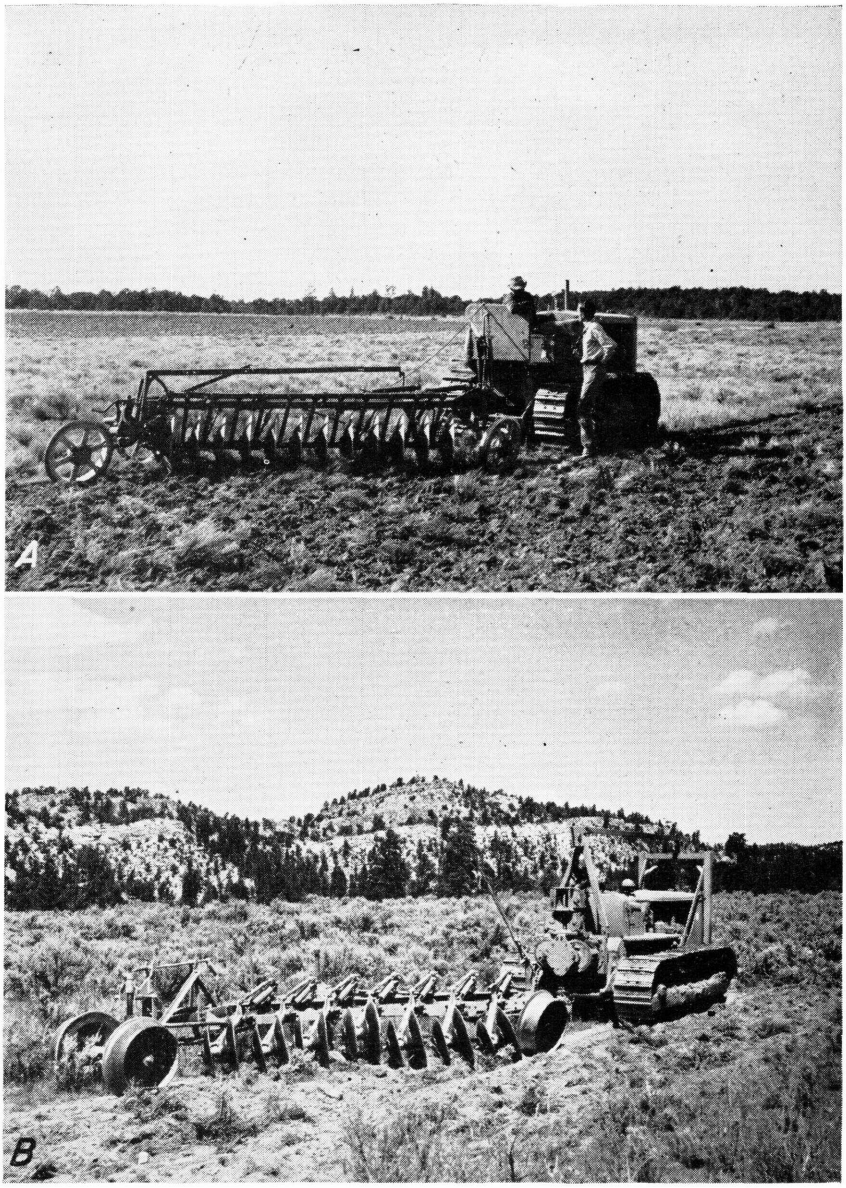


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FIGURE 6.—*A*, The wheatland plow is economical and practical for reducing competing vegetation in ponderosa pine and some pinyon-juniper woodland openings, but is not as effective as heavier plows for killing big sagebrush. *B*, The brushland plow combines the economy of the wheatland plow with the effectiveness of heavier plows. Spring tension control of disks allows the use of this equipment on ground too rough or rocky for other plows. Cost of site preparation is much reduced by pulling two plows with a special hitch. Soil disturbance should be as shallow as possible consistent with the best possible eradication of competing vegetation.

Power requirements for plows used in site preparation will be reduced if soil disturbance is as shallow as possible. When there is danger of wind and water erosion, the soil surface should be left in a rough condition to reduce this hazard. It is seldom necessary to plow deeper than 2 to 4 inches. Deeper plowing is less efficient and may result in turning a heavy subsoil on top of a more desirable sandy or sandy loam surface layer. Proper working of the soil not only destroys the competing vegetation, but also promotes absorption of water and provides for seed coverage. A firm, well-prepared seedbed covered with trash and litter conserves soil moisture and provides the best conditions for seedling establishment.

## Planting

*Covering.*—Crested wheatgrass sprouts best when seed is covered with ¼ inch to 1 inch of soil. Establishment of seedlings is poor when seed is left on the soil surface. It is poor also when coverage is greater than 1 inch. If seed is covered 3 inches deep, there will be very few seedlings.

*Rate and spacing.*—The amount of seed used and the spacing of the rows should be adjusted with the aim of having the site just fully occupied by plants. Overplanting wastes seed and results in severe competition among the young seedlings. If the sowing rate is insufficient, the development of a full stand is delayed several years.

Although much is still to be learned about proper rate and spacing for crested wheatgrass in the Southwest, experimental plantings during the last 5 years have furnished some useful guides. For example, on sites where annual rainfall is less than 15 inches, test plantings in 24-inch drill rows at a rate of 4 pounds per acre produced the most forage (table 2). Where annual rainfall is consistently 23 inches or more, good soil protection and forage production were attained by planting up to 12 pounds of seed in 6-inch drill rows. A general recommendation for most planting situations is to drill crested wheatgrass at the rate of 6 pounds per acre in rows 12 inches apart. This rate appears to give satisfactory forage production and provides a good ground cover for protection against erosion and the invasion of undesirable weedy plants. Any deviation from this standard should

TABLE 2.—*Herbage production of crested wheatgrass with different row spacings, seeding rates, and precipitation rates*

| Location | Average annual precipitation | Row spacing | Seeding rate | Air-dry herbage yield in 1949 |
|---|---|---|---|---|
| | *Inches* | *Inches* | *Pounds/acre* | *Pounds/acre* |
| Fort Valley, Ariz. | 23 | 6 | 12 | 1,870 |
| | 23 | 12 | 6 | 1,820 |
| | 23 | 18 | 4 | 1,560 |
| Dog Knobs, Ariz. | 14 | 8 | 12 | 550 |
| | 14 | 16 | 6 | 500 |
| | 14 | 24 | 4 | 640 |

be toward higher seed planting rates and closer rows on moist sites, and the opposite on dry sites. Regardless of initial differences in the rate of seeding and the spacing distance between the rows, herbage production and density tend in time to become adjusted to average moisture conditions.

The seeding rates here recommended are based upon trials with seed having purity and germination rates of at least 90 percent. If it is necessary to use seed of poorer quality, adjustments in seeding rates can be determined as follows:

$$\frac{\text{Pounds per acre recommended} \times 0.8}{\text{percent purity} \times \text{percent germination}} = \text{pounds per acre to be planted}$$

*Method of planting.*—The best control of depth of coverage and rate of seeding is obtained by drilling. Drilling proved superior to broadcasting ahead of the plow, broadcasting after the plow, and covering broadcast seed with a disk harrow, on an experimental site where big sagebrush was eliminated by plowing. On a pinyon-juniper experimental site, drilling produced better stands than either broadcasting and covering with a harrow or planting with a cultipacker. Drilling costs slightly more than broadcasting but gives more efficient use of seed and better establishment, so that the additional cost is easily offset.

Farm grain drills are not made for use on rough range lands. However, with some modifications and with care in operation, they will stand the stress. Single-disk grain drills equipped with chain drags are best for most site conditions. On comparatively trash-free seedbeds, double-disk grain drills equipped with depth flanges have also proved satisfactory. Breakage can be reduced on either type of drill by plugging alternate seed openings and removing corresponding disks and tubes. This modification permits pieces of brush and other trash to pass between the remaining disks with less damage to the drill; it also conforms with the general recommendation of 12-inch drill rows.

Crested wheatgrass is sown from the regular grain box, which should be calibrated to assure proper planting rates. A speed reducer unit on the feed mechanism is necessary on some makes to attain proper seeding rates. Equipment should be operated at 2 to 3 miles per hour. Care should be taken to ease over such obstructions as rocks, stumps, and brush piles. On large plantings, costs can be reduced by using a multiple hitch which will handle two or three drills at the same time.

For excessively rough, rocky, or trashy seedbeds, broadcasting is sometimes the only practical method. Broadcasting requires more seed than drilling because distribution and coverage of seed is less uniform. In general, the aim should be to distribute about 25 live seeds per square foot. Seeding rates should be increased about 25 to 50 percent over the amount recommended for drilling on the same site. Provision should always be made for coverage after broadcasting by such means as a brush, chain, or pipe-harrow drag. Weight of the drag should be adjusted to cover the seed no deeper than 1 inch.

*Time of planting.*—In most parts of Arizona and New Mexico, summer plantings of crested wheatgrass have given the best results. Fall

plantings rank second. In most parts of Arizona and New Mexico the driest weather occurs in May and June, whereas July and August are the months of greatest rainfall. The remaining months of the year have intermediate amounts of rainfall. The chart presented in figure 7 shows what an important factor rainfall distribution was in assuring success with crested wheatgrass at Fort Valley, Ariz. Test results have been similarly affected by rainfall distribution in most other areas. Planting in July just prior to the summer rains results in most consistent success. Seed planted during the summer has a good chance of remaining moist so that it can germinate and produce strong seedlings that will not be winterkilled. Even summer plantings may fail in years when rainfall is much below the average.

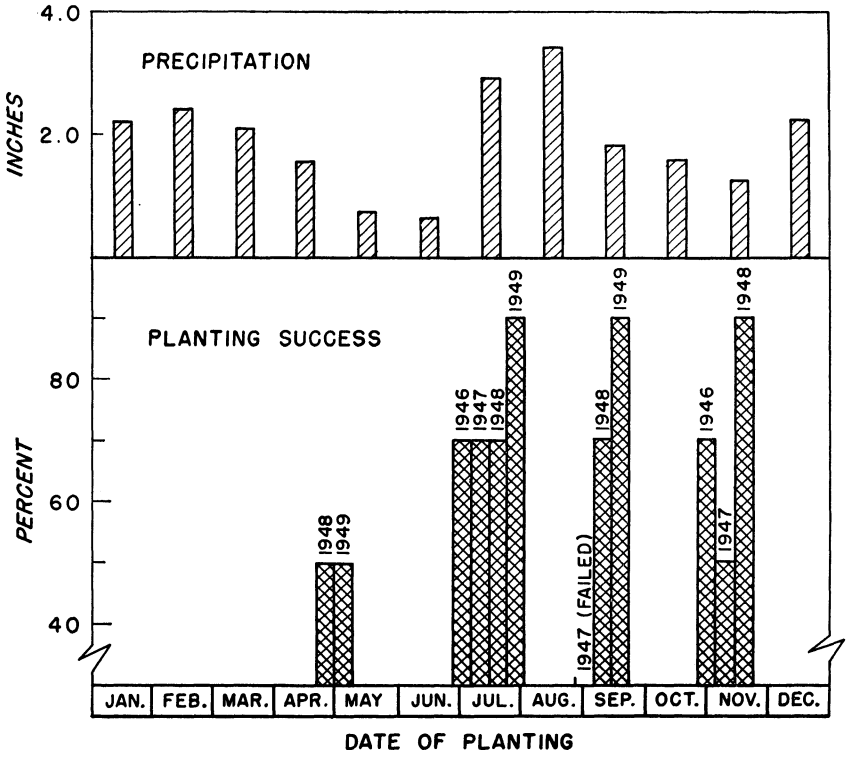


FIGURE 7.—Seasonal planting success with crested wheatgrass in relation to average monthly distribution of precipitation at Fort Valley, Ariz.

Early fall plantings are less likely to succeed than summer plantings because rainfall conditions are poorer, and the seedlings are sometimes too weak to resist frost heaving if there is no snow cover during the following winter. To be successful late fall plantings must have good snow cover during the winter and loss of soil moisture during the spring must be slow. In the plains area of northeastern New Mexico, east of the Sangre de Cristo Mountains, the more dependable May and June rainfall makes spring plantings possible.

## JUDGING PLANTING SUCCESS

Success or failure of a planting should not be judged too quickly. Growers have destroyed satisfactory plantings and replanted because they failed to evaluate a stand properly.

The first-season growth of a planting of crested wheatgrass may be deceiving. Crested wheatgrass seedlings may be small and unimpressive. They may consist of only 2 or 3 threadlike leaves 1 or 2 inches long at the end of the first growing season and still develop into vigorous plants. Stands reported as failures have often developed successfully in the second or third growing season. Where there is considerable competition from weeds, such as Russian-thistle, even longer periods may be necessary before crested wheatgrass appears dominant. As a general rule it is always well to wait at least two growing seasons before making a final judgment as to the success of a planting.

In a summer planting area such as the Southwest, the rainfall distribution during the year in which crested wheatgrass is planted has a great influence on its initial establishment. With high rainfall of good distribution almost all viable seeds may germinate and produce established seedlings. If initial establishment is obtained under poorer growth conditions, it may take several years for a full stand to develop.

The final stand of crested wheatgrass obtained on any site will depend considerably on the average moisture conditions. Within the planting range of crested wheatgrass the number of plants established at the end of two growing seasons should be about one plant per square foot in the drier situations and should vary upward to more than three plants per square foot in moister openings in ponderosa pine forests. A complete ground cover cannot be expected.

Where stand establishment is not up to expectations at the end of 2 years, improvement in number of plants can often be obtained by grazing that permits seed distribution and coverage resulting from light trampling. If enough additional seedlings are obtained, grazing should be especially light or should be eliminated entirely the following year. On Glorieta Mesa in New Mexico, a definite improvement resulted from light, early fall grazing of a thin stand of crested wheatgrass. The stand was 2 years of age at first grazing, plants were poorly distributed, and no new seedlings were developing. After 2 years of light grazing nearly all bare spots had filled in with seedlings, and a full stand of plants eventually developed.

## GRAZING RESEEDED AREAS

### When to Graze Newly Seeded Areas

New crested wheatgrass plantings are usually ready for grazing at the end of the second growing season. Grazing should, however, be delayed until the third growing season or longer if plants have not matured enough to produce seed. Heavy grazing too early in the life of a stand retards and may even prevent satisfactory stand establishment.

## Season of Use

Crested wheatgrass furnishes the best forage during the spring and early fall. Plants commence growth early in the spring and under favorable conditions form seedheads by June, which is about a month before summer-growing native grasses, such as gramas, muhlys, and dropseeds, commence rapid growth. During the late summer and early fall, if soil moisture is favorable, mature crested wheatgrass plants will green up and make considerable regrowth. Because of its spring-fall growth periods, crested wheatgrass has a special value as calving or lambing range during the early spring, and as finishing forage during the fall. Cattle do well on it, however, during a May to October grazing season.

Spring and fall grazing of crested wheatgrass takes advantage of the growth periods when nutrient levels are the highest. As in most grasses protein and other nutrients of crested wheatgrass are highest during the early stages of growth. Crude fiber increases and digestible nutrients decline with age. Nutritional value picks up again with fall regrowth. At four sites in northern New Mexico, where early fall rains stimulated regrowth, crude protein of composite samples of new and old growth reached values of 6 to 10 percent. The leaching effect of fall rains will, however, lower nutritive values of dry herbage. For example, at one site in northern New Mexico 5 inches of rainfall in the late fall lowered crude protein to about 2 percent.

Spring grazing should not be started until the soil is dry enough so that livestock can walk on it without leaving deep hoof impressions. Grazing on wet soils may result in compaction and the lowering of the infiltration and moisture-holding capacity of the soil. Plants should have new leaves at least 4 inches long.

## Degree of Use

Crested wheatgrass forage production may be maintained and the best individual animal weight gains may be obtained on Arizona and New Mexico reseeded ranges when the amount of herbage eaten averages about 45 percent by weight and does not exceed 55 percent in any year.

That such utilization standards are advisable is indicated by a limited grazing study made near Pecos, N. Mex., in 1948, 1949, and 1950. A group of small experimental pastures was grazed at four intensities for about 1 month in the fall of each year. The four grazing intensities were as follows: Very heavy grazing—an average of over 75 percent of the total herbage produced by crested wheatgrass being eaten; heavy grazing—56 to 75 percent of the herbage removed; moderate grazing—36 to 55 percent; and light grazing—15 to 35 percent. Cattle made satisfactory fall gains on mature crested wheatgrass at moderate and light grazing intensities, and even when grazing was heavy (table 3). Average daily gains per animal ranged from 1.1 to 2.6 pounds. In each year moderate grazing proved better than heavier grazing. Poorest gains were made on the very heavily grazed pastures.

TABLE 3.—*Relation of grazing intensity to the average daily weight gains of cattle in early fall grazing of crested wheatgrass, Pecos, N. Mex.*

| Year | Class of cattle | Grazing intensity and percent utilization | | | |
|---|---|---|---|---|---|
| | | Very heavy—over 75 | Heavy—56–75 | Moderate—36–55 | Light—15–35 |
| | | *Pounds* | *Pounds* | *Pounds* | *Pounds* |
| 1948 | Young cows | | 1. 2 | 1. 3 | |
| 1949 | Yearling steers | 1. 1 | 1. 4 | 1. 5 | 1. 7 |
| 1950 | Yearling heifers | 1. 2 | 1. 9 | 2. 6 | 1. 8 |
| | Average | 1. 1 | 1. 5 | 1. 8 | 1. 7 |

A gain of about 2 pounds a day per cow can be expected from the use of crested wheatgrass in northern New Mexico. On a comparable site on the Dixie National Forest in southern Utah, gains per cow over a 7-year period averaged 2.1 pounds per day on crested wheatgrass compared with 1.1 pounds for range supporting good native forage plants. The grazing season covered 4 months in summer.

The degree of grazing has an important bearing on the maintenance of vigor and production of crested wheatgrass year after year. Records were made of the herbage production on the Pecos experimental ranges under various stocking rates, for the years 1949–51. The ranges were grazed in the fall season. The average herbage production per acre after 3 years of grazing was as follows:

| | *Percent of herbage eaten* | *Pounds of herbage produced* |
|---|---|---|
| No grazing | 0 | 590 |
| Light grazing | 15–35 | 595 |
| Moderate grazing | 36–55 | 535 |
| Heavy grazing | 56–75 | 460 |
| Very heavy grazing | Over 75 | 340 |

Under heavy and very heavy grazing, loss of vigor, height growth, and crown spread, and death of individual plants resulted in serious loss in herbage production as compared with production under more moderate grazing. After 3 years of moderate grazing in this test, herbage production dropped slightly. However, because severe drought conditions prevailed during the testing period, this drop is not considered serious.

For greatest sustained returns from crested wheatgrass, grazing should be stopped when total herbage consumption reaches 45 percent by weight each year. Such a system of management requires annual adjustments in stocking, because forage yields vary widely with yearly weather changes. For example, during the period 1948–51 differences in forage production at a typical ponderosa pine site in Arizona caused permissible stocking rates to vary from 0.8 to 2.2 acres per animal month, and at a typical pinyon-juniper site in New Mexico from 1.2 to 5.3 acres per animal month.

To determine when proper use of herbage has been reached each year, careful observation is necessary. Experienced persons may rely on their estimates from the general appearance of the grass stand. One of the simplest guides to proper use is close inspection of individual plants. Measurements have shown that when proper use of the herbage is reached, at least 30 percent of the individual plants in a stand remain ungrazed.

If annual adjustments in stocking are not possible, the alternative choice—stocking at the lower limits of grass production—should be followed to insure that the stand will be maintained. Safe stocking limits are about 2 acres per cow month for ponderosa pine and moist sagebrush sites, and about 5 acres per cow month for pinyon-juniper woodland sites.

## OTHER RETURNS

Range plantings of crested wheatgrass can sometimes be harvested profitably for seed. In northern New Mexico operators have harvested more than 350 pounds of seed per acre on range plantings 2 years old. However, 100 pounds of seed per acre is generally considered a satisfactory yield from dry-land plantings. On favorable ground ordinary grain combines, if properly adjusted, can be used to harvest crested wheatgrass seed.

Other benefits, besides the production of more forage, may be obtained by restoring deteriorated range lands with crested wheatgrass. On many deteriorated sites replacement of a scant annual grass and weed cover with perennial grass reduces soil erosion and increases the absorption of rainfall and snow melt by the soil. Moreover, a good stand of the perennial crested wheatgrass is more effective than the shrubs it replaces in making it easy for water to enter the soil, and in reducing surface runoff and erosion.

Wild game, such as deer and turkey, benefit by an increased supply of green forage in spring and of grass seeds in the fall. Crested wheatgrass has also been used near recreational areas to stabilize the soil and improve the scenic effect.

Crested wheatgrass has many uses, and as more information concerning its possibilities becomes available, it will probably be used more widely than at present to increase and maintain the productive capacity of range lands in the Southwest.

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# Clean Grain

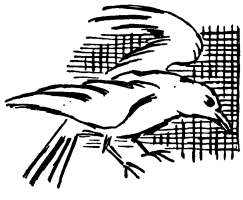
## Makes wholesome flour and cereal products

### Cleanliness in grain begins on the farm

Insects, birds, and rats and other rodents that get into stored grain cause enormous losses. They waste the nation's food and eat away your profits. You can help cut these losses by making sure that all the grain you store and handle is clean.

**Keep rats and mice out** with better storage construction. Poison and trap rodents and clean up places where they may hide and live.

**Keep insects out.** Fumigate old stored grain. Before storing new grain, get rid of insects by cleaning the bins and areas surrounding them. Spray bins with insecticide.



**Use screens to keep out birds and poultry.** Use ½-inch mesh hardware cloth or similar material over all windows and other openings.

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